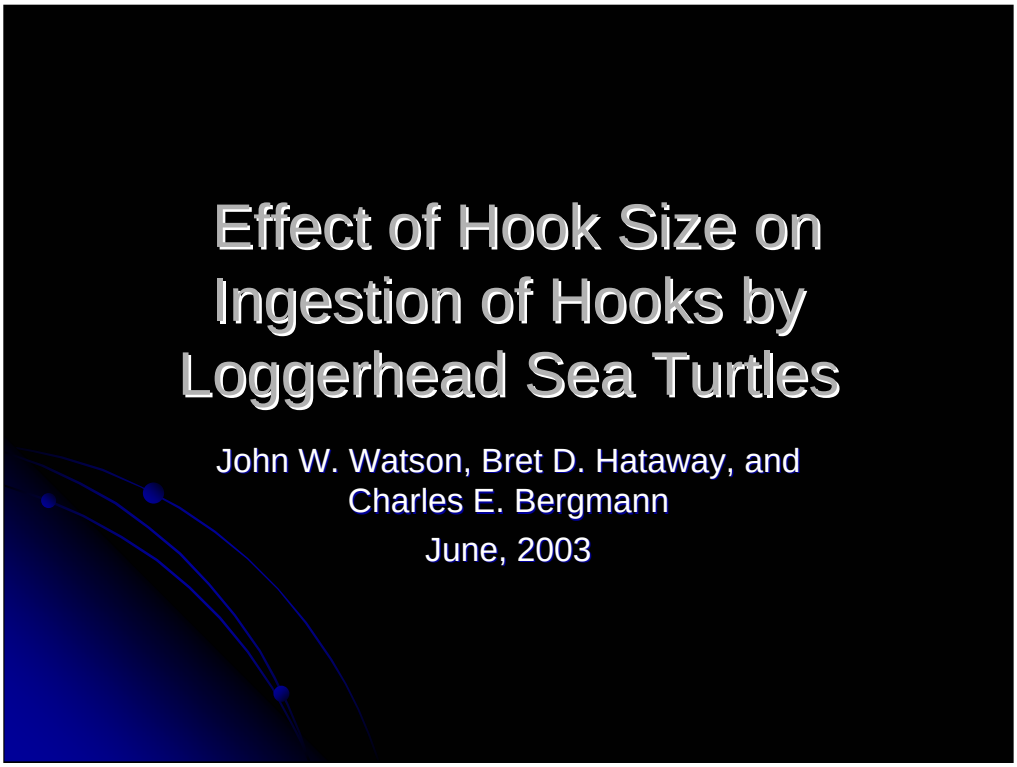
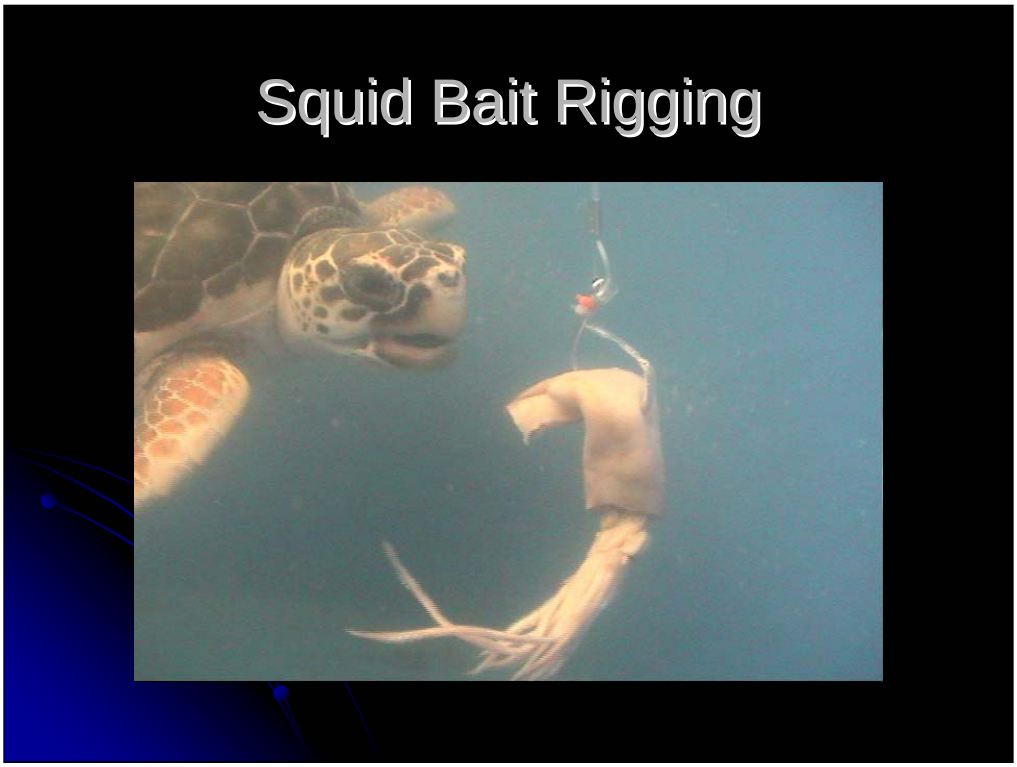


NOAA Fisheries Southeast Fisheries Science Center conducted feeding studies using captive reared loggerhead (*Caretta caretta*) sea turtles to investigate the effect of hook size on ingestion of hooks used in the pelagic longline fishery. This research was conducted in conjunction with research being conducted in the Western Atlantic Ocean to develop mitigation measures to reduce the capture and mortality of sea turtles by pelagic longline fishing gear (http://www.mslabs.noaa.gov/watson2.pdf). The turtles used in these experiments were reared at the NOAA Fisheries Galveston, Texas Laboratory. The turtles are used in annual shrimp trawl turtle excluder device certification tests at the NOAA Fisheries Panama City, Florida Laboratory by the NOAA Fisheries Mississippi Laboratories in Pascagoula, Mississippi. In June of 2003, NOAA Fisheries investigated potential longline mitigation techniques including hook design and size effect on ingestion of hooks, which is the primary cause of mortality associated with pelagic longline gear. Turtles between 44 cm. and 58.8 cm. in straight line carapace length (size of loggerhead turtles encountered in pelagic longline fisheries in the Western Atlantic is 40-65 cm) were used for these experiments.

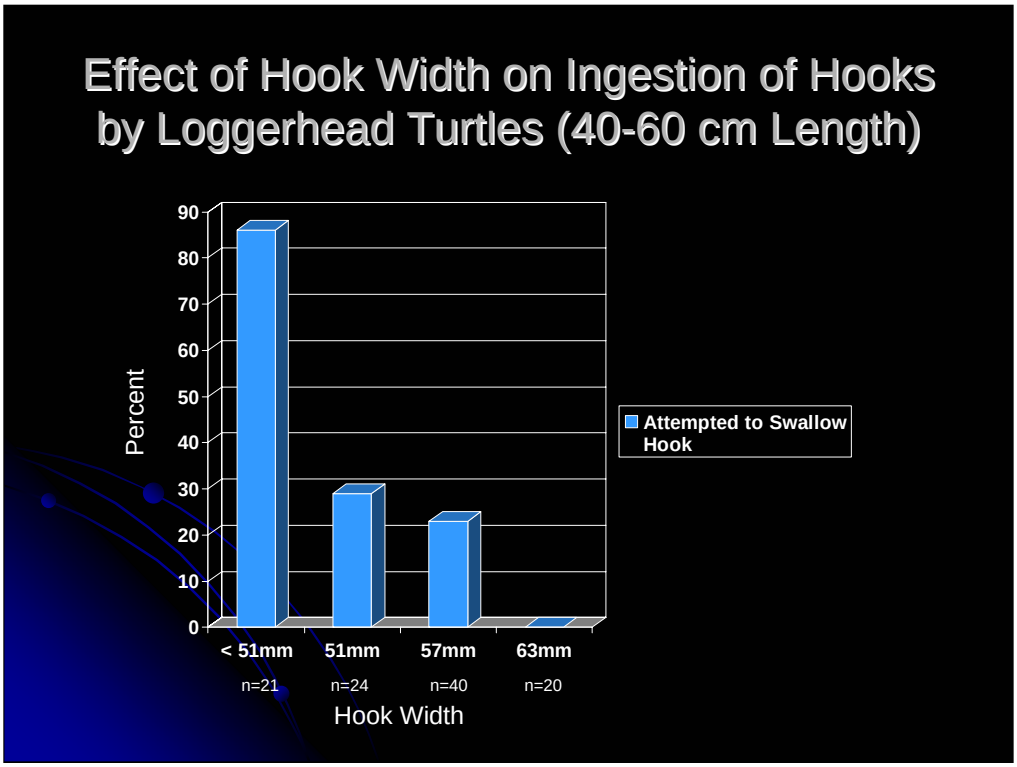


Squid baiting method used in the experiments. Squid bait was the primary bait used in the experiments and was used on all hook types. Squid used in the experiments were 150 to 250 gram weight.

The experimental procedure was to present turtles a baited hook. The turtle response was recorded by an observer as four categories. The categories were:

1. Did not take the hook into mouth.
2. Took the hook partially into mouth.
3. Took the hook fully into mouth.
4. Attempted to swallow the hook.

Turtles were observed carefully by the researchers and once the hook was fully in the mouth and the turtle continued to swallow the bait, the hook and bait were pulled out of the mouth. Turtles were not allowed to actually swallow the hook.



Hook size had significant effect on the ingestion of hooks by loggerhead turtles between 40 and 60 cm in length. Ingestion of hooks and impact of associated leader material on loggerhead sea turtles is the most significant cause of mortality of the turtles which are incidentally captured by pelagic longline fishing gear. The predominant hooks used in pelagic longline fisheries are less than 51 mm in width. Using hooks larger than 51 mm in width has the potential to significantly reduce mortality of loggerhead sea turtles incidentally captured by pelagic longline fisheries.

Summary of Logistic Regression Analysis on Hook Swallowing Attempts

Explanatory Variable	Coefficient (SE)	Odds Ratio (90% CI)	*p value*
Turtle Size CCL (mm)	0.015 (0.006)	1.015 (1.004-1.026)	0.0196
Hook Width (mm)	-0.157 (0.045)	0.855 (0.794-0.921)	0.0005
Hook Length (mm)	-0.043 (0.024)	0.958 (0.920-0.997)	0.0772

Squid Bait only, n=105
Stepwise technique used with a sig level of 0.1 for model entry and retention
Hosmer and Lemeshow Goodness-of-Fit Test: Chi-Sqr=8.38, df=7, p = 0.2998

Logistic modeling focused on the variables turtle size (mm), hook width (mm), and hook length (mm) as predictors of swallowing attempt. The terms turtle size and hook width are significant (p=0.0196 and p-0.0005, respectively) and hook length is a marginally significant (p=0.0772) predictor. This suggests that swallowing attempt should be looked at as a function of these three variables simultaneously.

As expected, the model suggests that the probability of swallowing increases with (increasing) turtle size and decreases with (increasing) hook width and hook length. The table gives the coefficients, standard errors, and odds ratios, and 90% confidence intervals for each variable.

The odds of swallowing increases by a multiplicative factor of 1.5% with one mm increase in turtle size. This means that the odds of swallowing increase by 25% with 15 mm increase in turtle size, by 50% with 27 mm increase in turtle size, and the odds doubles with 47 mm increase in turtle size.

The odds of swallowing decreases by a multiplicative factor of 14.5% with one mm increase in hook width. This means that the odds of swallowing decrease by 37.5% with 3 mm increase in hook width, by 67% with 7 mm increase in hook width, and by 85% with 12 mm increase in hook width.

The odds of swallowing decrease by a multiplicative factor of 4.2% with one mm increase in hook length. This means that the odds of swallowing decrease by 19% with 5 mm increase in hook length, by 35% with 10 mm increase in hook length, and 50% by 16 mm increase in hook length.

Caution should be exercised in extrapolating beyond the ranges considered here for the predictors.

Hook Dimensions

Hook Type	Hook Width	Hook Length
9/0 J	41 mm	78 mm
9/0 Tuna	33 mm	78 mm
10/0 Tuna	38 mm	86 mm
11/0 J	51 mm	98 mm
16/0 Circle	51 mm	73 mm
11/0 MJ	56 mm	86 mm
18/0 Circle	57 mm	86 mm
12/0 J	57 mm	111 mm
14/0 J	63 mm	130 mm
20/0 Circle	63 mm	100 mm

Length and widths of hook types evaluated.